

Article

The Correlations of Blight, Crime, and Litter: A Path Analysis with Urban Morphology

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Abstract

Urban blight, crime, and litter are subjects of the vast urban studies literature, albeit treated separately when linked to the physical features of built and natural environments. Thus, the discussions of blight, crime, and litter in the literature mask the significance of their relationship vis-a-vis the spatial form of cities. We address this gap in the urban studies literature with a path analytic approach informed by urban morphology, from the Chicago School to New Urbanism, which sheds light on the spatial form of cities as a structural determinant of the interrelated blight, crime, and litter. In a path analysis, we specify the structure and determine the degree and significance of the direct and indirect relationships among blight, crime, and litter endogenously, with the socio-economic-spatial indicators at the block group level exogenously, including land use (mix), density, walkability, income, race, and neighborhood concentrated disadvantage. We augment the block group-level census economic and demographic data with local government land use and institutional documentation of neighborhood conditions, public safety, and 311 calls—incidents of blight, crime, and litter, respectively—for a case study of Memphis, Tennessee. A geographic information system (GIS) aids in the geocoding and aggregation of data at the census block group level approximating neighborhoods. The findings, with standardized weights signifying the relative dominance of blight, crime, and litter, inform and fine-tune planning and public policy targeted to neighborhoods. This study concludes with a discussion of urban revitalization implications.

Keywords: blight; crime; litter; neighborhood; concentrated disadvantage; block group; urban morphology; path analysis; GIS

Academic Editor: Bindong Sun

Received: 11 July 2026

Accepted: 24 July 2026

Published: 4 August 2026

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1. Introduction

Blight, crime, and litter are subjects of the vast urban studies literature. However, mainly sociological or criminological studies rarely address the significance of their inter-relationship morphologically, which is holistically linked to the physical form of cities. The association of blight and crime appears early in urban studies literature, in observational studies with both social and physical determinants. Well known is Wilson and Kelling's [1] "broken windows thesis." Recent studies point out other physical features of built environments in addition to windows: unmaintained, abandoned, vacant lots and properties; dilapidated buildings; and boarded-up storefronts [2–10]. Crime reduction through environmental design (CPTED) highlights the built environment features

targeted to improve safety [11]. Chalfin et al. [12] provided evidence of crime reduction through street lighting in public housing. Others report on landscaping to enhance visibility that improves public safety. For a review of CPTED, see [13]; see also the International CPTED Association [14].

The relevance of urban morphology, the study of physical form, to criminological and sociological discussions of blight, litter, and crime, is suggested by a common denominator overlooked in the literature on urban studies. That common denominator is, in the nomenclature, the use of the term “disorder”. Notably, the term “disorder” is commonly used in academic discussions of sociology, criminology and urban morphology. In urban morphology, disorder is used interchangeably with urban sprawl, and the related term blight, which characterizes an undesirable physical form of urban growth [15–17]. In sociology and criminology, disorder is explained by (deviant) social behavior, just as in urban morphology, sprawl is a deviation from good city form [18,19]. Banai et al. [19] (pp. 3–7) note, “According to information theory, high entropy is the most probable, yet least predictable, state that leads to disorder.” [20,21]. Entropy is used to gauge urban sprawl [22–24], a phenomenon laden with “disorder” and the challenges of “predictability”. The plausibility of the concept of entropy for measuring the magnitude of “disorder,” departure or dispersion from a “socio-spatial organization” is suggested [19,25]. Interestingly, criminology and urban morphology increasingly exhibit a rarely acknowledged commonality: a concern with space, place, location, land use, and socio-spatial organization. Thereby, empirical studies of crime are vying for the spatial patterns and spatial units that better account for the incidence and location of crime in cities.

Two theories inform discussions of crime in connection to the urban form at various spatial scales (block, parcel, and land use): crime pattern theory and routine activity theory [26,27]. Aligned with theories that describe the spatial pattern of crime in cities, e.g., crime pattern theory, or its association with the elements of the built environment, e.g., the broken windows theory, empirical studies invoke urban morphology at a variety of spatial scales—from the block group to the parcel and the street [27]. Crime pattern theory’s nomenclature includes nodes, paths, and edges. Coincidentally, Lynch [28] argued the imageability or legibility of a city’s form is cognitively determined by the strengths of the relationships among five elements, namely paths, nodes, districts, edges, and nodes, albeit the cognitive link is rarely explored in empirical investigations of crime (see also Banai [29]). Arguably, the observation of the connections of the elements adds luster to the aforementioned theories of crime prevention, in which their interrelationships are overlooked. Empirical studies of blight, crime and litter increasingly do invoke space and place, and land use distinguished by type, residential, commercial, industrial, park and open space. However, rarely, the interrelationship is informed by urban morphology normatively (e.g., [3,18,19,30–35]).

Criminogenic theories, broken windows theory, crime pattern theory, and CPTED do draw on the elements of urban form to address blight and crime, albeit piecemeal not holistically, scattered in a vast literature. However, rarely, normative urban theories and perspectives that describe good city form’s interconnected parts that function synergistically enter the discourse. Decades of urban theory since the turn of the century envisioning an urban form responsive to the socio-economic impact of the industrial revolution are overlooked for the criminology–sociology–urban morphology nexus in the discourse of blight, crime, and, increasingly, litter. While the blight and crime connection is addressed, the impact of urban morphology on the interrelated components of crime, blight, and litter remain unexamined. We address this shortcoming in the urban studies literature.

In the section that follows, we provide a brief historical review of the theories and perspectives that describe the city form with characteristics that provide a whole that is more than the sum of the individual elements. Normative theories of urban form envision a holistic order that contrasts disorder (physical and social), also known as sprawl,

resulting in blight that correlates with crime and litter [5,6,11,18,19,25,36,37]. We highlight the discussion of crime and blight in urban morphology that predates contemporary observational studies of sociologists and criminologists since the Chicago School. We cite studies of blight and crime in light of the perspectives and theories of urban form, which we review briefly (Section 2). However, viewed as a two-way street, empirical studies reveal the strengths as well as limits of urban theory in practice. In the final section, we develop path analytic models of the relationship among blight, crime, and litter informed by urban morphology. The path analysis effectively renders a synthesis of the determinants of blight, crime, and litter linked to the elements of urban form. Furthermore, the relative importance of urban morphological elements—density, land use diversity, walkability—otherwise stated universally or generically and scattered in the literature, is determined in context by site-specific observations of the connections of blight, litter, and crime in a city case study [18,30,36,38–41].

2. Urban Morphology

2.1. *Chicago School of Urban Sociology*

Discussions of crime and social disorder appear early with developments in urban theory. The Chicago School of urban sociology's diagnosis of crime and disorder contextualized city growth by a set of concentric zones. Concentric zone theory (CZT) describes the land use and socio-economic enclaves from the urban core to the periphery, the commuter zone [42–44]. Near the center is the location of the factory and the worker residents labeled as “transitional.” As the city grows outward, this inner zone decays, characterized by blight and crime. The connection of the social (dis)order and the urban form—land use—is at the kernel of the concentric zone theory.

In their focus on socio-economic grouping and spatial extent, Dahir et al. [45] observed service calls related to blight, litter, and physical disorder differentiated by socio-economic status across urban space akin to CZT. Similarly, Wo [46] focused on land use. Wo [46] determined an association between mixed land use—differentiated by socio-demographic characteristics—and neighborhood crime.

It is not our intention here to provide an exhaustive review of the literature; it suffices to highlight that, akin to the Chicago School of urban sociology, recent investigations conceptually and methodologically link the incidence of blight, crime, and litter (also termed social disorder) to the elements of urban form, however piecemeal, scattered in the literature. And the studies are more aligned with urban sociology and criminology than urban morphology. Could social (dis)order be adequately investigated without consideration of physical (dis)order, as if behavior is considered independently from the environment? Descriptive theories explaining the growth of the city as well as normative theories prescribing good city form (order), from classic to the contemporary, are patently absent from sociological and criminological studies of social disorder—blight, crime, and litter [18]. However, urban theory informs studies of social disorder. We provide a brief review of the physical and social nexus in urban morphology.

2.2. *Urban Utopias from Garden City to Radiant City to Broadacre City*

Theories and perspectives of a city form that is orderly rather than chaotic emerged prominently in response to disorder, both physical and social, brought about by rapid industrialization, beginning in the eighteenth century to the turn of the nineteenth century—over-crowding, pollution, congestion, disease, insanitary conditions, poor living conditions in tenements, encroachment of industry over open space.

The parks movement was a response. LeGates and Stout [47] (p. 60) remind us about a pioneer of the parks movement, known for the design of New York City Central Park,

among many other projects—Olmsted. The park is regarded as a place to “nurture and preserve social morality,” a means “to control vice and provide healthy outlets for the city’s poor and working class populations” (see also [48]). For discussions of the connection of greening vacant lots and the impact on crime reduction and prevention, see [49,50]. The nexus of urban form and social behavior (disorder) is immediately implied: the urban spatial structure is determined by the organization of open space. Two prominent perspectives deal with disorderly physical urban conditions in the first decades of the twentieth century—Howard’s Garden City (Howard) and Le Corbusier’s Radiant City [51,52].

The central theme of the Garden City is to take the pressure off limited land and resources in the crowded, congested, polluted central city and distribute population, employment, and services regionally into smaller cities with balanced housing, jobs, services, and green space as well as rail connections to each other and the central city. The low-density Garden Cities are surrounded by an agricultural belt that effectively limits disorderly growth (sprawl) into the countryside—the State of Oregon in the U.S. pioneered urban growth boundary legislation in the 1970s to limit the sprawl of Portland and preserve farmland. Residents’ access to nature, otherwise encroached upon in the industrial city, is thereby ensured in the Garden City.

The Garden City with rail connectivity and regional mobility is regarded as a forerunner of transit-oriented development, which emerged in the 1980s as New Urbanism [36,41,53]. However, the North American suburban developments did not generally retain the job/housing, self-contained features of the Garden City. The result: suburban sprawl, considered as a structural source of regional inequity [36], the blighted inner city, considered as a structural and institutional source of crime, and the related litter in cities [5,35,54,55]. The nexus of crime and blight is recorded in a vast urban studies literature, highlighting the physical features characterized by vacant properties, boarded-up stores, abandoned industries, desolate interstitial spaces, vast surface parking around formerly viable retail and industrial structures, whether urban or suburban, also known as greyfields and brownfields, and the like [9,56]. To reduce crime, improve the physical environment, as crime reduction through environmental design strategy advocated, noted above.

Responsive to the emergent industrialization and urbanization in the first decades of the twentieth century, particularly the encroachment of open space in cities, Le Corbusier [52] proposed the Radiant City. Compared to Howard’s low-density Garden City population of 32,000, the Radiant City accommodated 3,000,000 residents. With a nearly 100-times larger size, the Radiant City provided high-rise buildings surrounded by open space, also known as “tower-in-the park.” The high rise is a ubiquitous modern and postmodern city feature; it is a form that follows a function that accommodates (housing) but also symbolizes the global city competitive advantage with the image of the skyline (as in the world’s tallest skyscraper in Dubai, Burj Khalifa).

Just as in the Garden City, the concept of the tower-in-the park did not fulfill expectations everywhere in implementation, notwithstanding the global impact. Particularly for low-income residents, the high-rise inaccessibility to jobs, neighborhood services, and reliable public transit exemplified concentrated poverty, a recipe for social disorder (crime) intensified by physical disorder—blight (see below how we measure the impact of “concentrated disadvantage” on blight, litter, and crime in a path analysis). The image of the blight, litter, and crime tower-in-desolate parking lot replaced the tower-in-(viable) park. The high rise is a public housing prototype universally adopted by governments until dynamiting Pruitt-Igoe—a public housing project that epitomized the failures of public housing in the U. S. with blight and crime (see also [57]). Harvey [58] cites the demise of Pruitt-Igoe as a landmark characterizing the turn from modernism to postmodernism.

Discussions of urban utopias are incomplete without Wright’s Broadacre City [59]. Wright’s prairie-style organic architecture envisioned a low-density urbanism (one

dwelling unit per acre) in Broadacre's four-square-mile grid. In contradistinction to the high-density Radiant City, Broadacre accommodated a variety of housing types, from the small-scale Usonian to the 15-story apartment. However, Broadacre city is not merely defined by residential land use but also a factory with railway proximity. Thereby, the concept of community self-sufficiency with residential, agricultural, industrial and civic functions and railway as well as roadway is akin to Howard's self-contained Garden City.

A striking morphological distinction is Broadacre's automobile dependence compared to Garden City railway and roadway connectivity. The consequence: urban sprawl, and its car dependence in the twenty-first century is associated with Broadacre, in contrast to New Urbanism's transit-oriented development that is linked to Garden City multi-modal accessibility [35,60]. However, the Garden City, the Radiant City, or the Broadacre City did not fully retain the integrity of the conceptual elements everywhere in implementation. Garden City turns out to be predominantly single-family residential but without retail, commercial and office space garden suburbs. Radiant city's "tower in the park" metamorphosed to tower in the parking lot. Broadacre's roadway remained, however, without the railway or the factory. Even apartment housing is discouraged or zoned-out in favor of mainly single-family residential suburbs [61,62].

New Urbanism is a response to the limitations of the utopian concepts of urbanism in implementation. Let us review urban form features that are also highlighted with alternative concepts of urbanism. Our brief review of urban morphology highlights urban form features with a causal, structural relationship to blight, crime, and litter [46,63,64]. However, the causal structure is rarely recorded in urban studies, particularly in how blight, crime, and litter are interrelated holistically with urban form.

2.3. *The New Urbanism*

Howard's Garden Cities that are linked by rail to each other and to the central city are regarded as a forerunner of New Urbanism's transit-oriented development [60,62]. New Urbanism emerged in the 1980s to counter suburban sprawl that effectively intensified auto-dependence. The blight, and the related crime and litter, in the U.S. inner city is intensified by the suburbanization of housing, services, and jobs [6,54,55,65–67]. Public transit is not a viable mobility option in the low-density inner city or suburbia [55]. New Urbanism's solution: mixed land use, fine-grained, increasing proximity and walkability through compact, pedestrian-friendly design if not density. Decades earlier, Jacobs [30] (p. 101) identified a universally held principle for cities: "cities need most intricate and close-grained diversity of uses that give each other constant mutual support, both economically and socially. The components of this diversity can differ enormously, but they must supplement each other in certain concrete ways."

Concomitantly, studies of crime, blight, and litter vie for accountability to the finer grain of the city structure down to the block, parcel, street, and facility [27,35,63,64,68,69]. Kounadi et al.'s [68] review is at the intersection of crime and space. Norita et al. [69] correlate property crime with land use. Groff and Lockwood's [63] focus on street crime is segmented with spatial variation in the facility threshold. Ioannidis et al.'s [64] analysis of residential and street crime is indexed by built form, enabled by remotely sensed data. Wang et al. [27] show the correlation of crime and facilities with land use variation in urban and suburban districts. Banai and Enayati Shabkolaei [35] show a strong, block-level positive correlation of blight and litter, a precursor to analysis of causation.

What do classical urban theories and contemporary urban morphologies tell us about how blight, litter, and crime are interrelated? The diagnosis and the response to "disorder," both physical and social, are a common thread in urban theory and perspectives. Defined concomitantly, sprawl that relates to blight, which in turn relates to litter and crime, is the observable manifestation of the disorder. The emphasis in the definition of disorder as

both physical and social recalls the controversy of physical determinism in urban theory. However, a careful reading from Garden City to Radiant City to Broadacre City and New Urbanism suggests otherwise. Howard's Garden City, titled *To-morrow: A Peaceful Path to Real Reform* [51], predated Garden Cities of Tomorrow [51]. Corbusier's and Wright's Radiant City and Broadacre City similarly rendered a physical and social synthesis with urban form, contentiously held views of urban sustainability notwithstanding. Let us briefly note the durable principles of sustainable urbanism that inform studies of blight, litter, and crime, starting with density.

Population density, a challenge for not just transit viability but urban sustainability, is also a factor in studies of blight and crime [5,19,55,62]. The urban form with a coarse grain of long blocks scaled for cars, not pedestrians, discourages walkability that otherwise would ensure safety and security. The lack of land use diversity perpetuates car dependency, in contradistinction to an urban form with mixed use in proximity that encourages walkability. Furthermore, the micro-architecture of the city with the location, design, and scale of individual buildings and facilities is not regarded indiscriminately in urban morphology. The broken windows of Pruitt-Igoe that brought about its ultimate destruction are a well-known case in point of housing facilities inaccessible to neighborhood services and jobs (see also Harvey [58]). In contrast to the de-humanized scale of the high-rise public housing project is New Urbanism's pedestrian scale of Hope VI and Choice Neighborhoods characterized by mixed-income residents with access to services and jobs [65,67].

Empirical studies of blight, crime, and litter do incorporate elements of the built environment—space, if not place, land use, if not land use mix, population density, walkability, and the public realm. However, the built-environment features appear piecemeal, disconnected, and scattered in a vast literature. Above all else, how does one discern their relative importance in studies of the interrelated blight, litter, and crime? Rarely, criminology turns to urban morphology for insightful perspectives.

Largely absent are the theories and perspectives advocated from Garden City to New Urbanism, briefly characterized above [18,36,38,41,62]. A contrasting aspect is the normative or prescriptive discourse that calls for how the physical form elements like density, land use diversity, and walkability are brought together in the discourse about good city form and urban sustainability characterized by the departure from disorder to order, toward a whole that is greater than the sum of the individual parts [18].

In the section that follows, blight, litter, and crime are structured with direct and indirect relationships to the elements of urban form in order to determine relative importance. In situations where the exogenous (independent) variables are posited with direct and indirect relationship to the endogenous (dependent) variables, a path analysis model is used to determine relative importance with statistical significance [11,70]. Such an approach is similar to a structural equation model (SEM) but is different from ordinary least squares (OLS) in regression (Section 3.1).

3. Path Analysis

3.1. A Brief Introduction

Population density, land use diversity, and walkability commonly axiomatically emerge as the desirable features of a sustainable urbanism—a built environment with physical attributes resistant to disorder (social and spatial)—in urban morphology from the classical to the contemporary. Commonly asserted in principle categorically, however, density, land use diversity and walkability's relative importance is rarely determined situationally, particularly in the context of urban blight, litter, and crime. We fill this void in the urban studies literature. We juxtapose the urban morphological and socio-economic factors that jointly inform the interrelated urban blight, litter, and crime. Racial composition, income, and concentrated disadvantage are the socio-economic factors. Together,

they constitute five independent variables, or exogenous variables, in path analysis terminology. Blight, litter, and crime constitute three dependent variables, or endogenous variables in path analysis parlance.

Our analytic intention is to determine the structure of the explanatory variable relationship with dependent variables, both directly and indirectly. OLS limits the number of dependent variables to one. We have three. SEM requires latent as well as observed variables. Our analysis is limited to the observed variables (see Section 3.2). Path analysis is the alternative to SEM, similarities notwithstanding. The variable relationships are assumed linear in path analysis, just as in OLS and SEM. However, variable log-transformation compensates when nonlinearity is detected. In our path analysis case, population density and income are log-transformed (Figure 1).

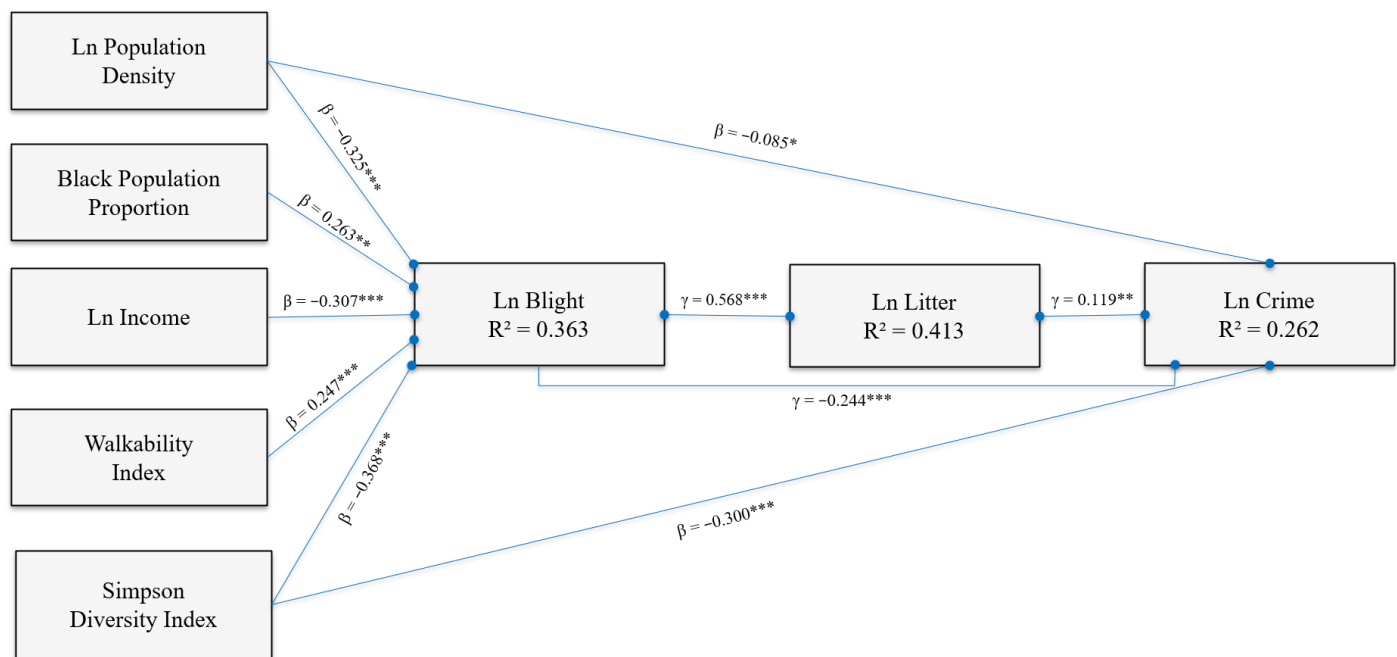


Figure 1. A path diagram with five independent (exogenous) variables (density, land use mix, block group median income, racial comp) and three dependent (endogenous) variables (blight, crime, and litter). Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Natural log-transformation is denoted by Ln.

The direct and indirect variable relationships are stated formulaically as in regression equations. For example, blight has direct relationships with the explanatory variables. Independent variable coefficients are denoted by β , with p -values included in Figure 1, error term denoted by e , coefficients for dependent variables denoted by γ .

For clarity of presentation facilitating interpretation of coefficient values, let $x_1 \dots x_5$ denote our five explanatory variables and y_1, y_2, y_3 the three dependent variables. For example, the direct coefficient of x_1 and y_1 is denoted by β_{11} , and the indirect path of x_1 with the dependent variable y_3 is denoted by γ_{13} .

Each dependent variable y is a linear combination of independent variables x plus an error term, e_y or a residual in regression terminology. In general,

$$y = \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_n x_n + e_y$$

In words,

$$\begin{aligned} \text{LnBlight} = & \beta_1 \text{LnDensity} + \beta_2 \%Black + \beta_3 \text{LnIncome} \\ & + \beta_4 \text{Walkability} + \beta_5 \text{Diversity} + e_{\text{LnBlight}} \end{aligned}$$

For example, total effect of LnDensity , x_1 , including the direct and indirect (or mediating) effects on LnCrime , y_3 , is calculated thus:

Direct: LnDensity, $x_1 \rightarrow \text{LnCrime}, y_3$, direct coefficient, β_{31} .

Indirect 1: LnDensity $x_1 \rightarrow \text{LnLitter } y_1 \rightarrow \text{LnCrime}, y_3$

Coefficients, $\beta_{11} \times \gamma_{31}$.

Indirect 2: LnDensity $x_1 \rightarrow \text{LnLitter } y_2 \rightarrow \text{LnCrime}, y_3$

Coefficients, $\beta_{21} \times \gamma_{32}$.

Indirect 3: LnDensity $x_1 \rightarrow \text{LnBlight } y_1 \rightarrow \text{LnLitter } y_2 \rightarrow \text{LnCrime}, y_3$.

Coefficients, $\beta_{11} \times \gamma_{21} \times \gamma_{32}$.

Total Effect of LnDensity, x_1 on LnCrime, y_3 :

Direct + Indirect:

$= \beta_{31} + (\beta_{11} \times \gamma_{31}) + (\beta_{11} \times \gamma_{31}) + (\beta_{11} \times \gamma_{21} \times \gamma_{32})$.

The total effects of the remaining explanatory variables are similarly determined.

3.2. Variables with Data Sources

The exogenous and endogenous variables included in path analysis with the sources of data are as follows (Figure 1). The spatial unit of analysis is census block group.

Litter. Specifically, illegal dumping incidents, sourced from the Memphis Data Hub, <https://open311.memphistn.gov/#!/view-data> (accessed on 10 January 2025)—both Open and Closed PW Service requests since 2016).

Blight. The City of Memphis Division of Planning and Development, representing the location of structures identified as abandoned, vacant, vandalized, or otherwise physically deteriorated.

Retrieved from Shelby County Land Bank Properties, Division of Public Works. <https://gisapps.shelbycountyttn.gov/landbank/> (accessed on 18 November 2024).

Bluff City Snapshot Property Survey October 2020, Data Midsouth, Innovate Memphis <https://info.datamidsouth.org/project-portals/bluff-city-snapshot-survey> (accessed on 18 November 2024).

Crime. The Public Safety Institute at the Memphis Data Hub, covering a range of reported incidents. <https://data.memphistn.gov/datasets/MEMEGIS::mpd-public-safety-incidents-1/about> (accessed on 15 January 2025)—Memphis Police Department—Public Safety Incidents—New).

Per Capita Income. Data were obtained from the American Community Survey (ACS) [71] [https://data.census.gov/table/ACSDT5Y2023.B19113?t=Income+and+Earnings&g=050XX00US47157\\$1500000&y=2023&d=ACS+5-Year+Estimates+Detailed+Tables](https://data.census.gov/table/ACSDT5Y2023.B19113?t=Income+and+Earnings&g=050XX00US47157$1500000&y=2023&d=ACS+5-Year+Estimates+Detailed+Tables) (accessed on 18 November 2024).

Land Use. <https://gis.shelbycountyttn.gov/zoning/> (accessed on 6 February 2024) [72,73].

To determine if land use in each block group is more or less diverse or mixed, we used Simpson's diversity index $0 \leq D \leq 1$, defined thus:

$$D = 1 - \sum_i^s p_i^2$$

where p_i is the proportion of block group land use, determined by $p_i = \frac{x_i}{\sum_i^s x_i}$.

Land use is denoted by types s , residential, commercial, industrial. Simpson diversity index D is bounded $0 \leq D \leq 1$; it connotes the least to most diverse land use.

The power in p_i^2 signifies sensitivity by using arithmetic mean ([74]; see also [19]).

Concentrated Disadvantage. Concentrated disadvantage is a composite metric that reflects the occurrence of enduring, propagating extreme poverty and structural disinvestment (e.g., redlining) within the city, commonly measured at the neighborhood level. The U.S. census tract geography and the finer block group provide socio-economic data used in sociological and criminological research on the neighborhood concentrated disadvantage and crime [75–79].

We used socio-economic indicators at the kernel of commonly used neighborhood disadvantage research [75,80] with 2023 American Community Survey (ACS) block group

data for Shelby County, Tennessee. The neighborhood concentrated disadvantage (CDI) variables were derived from the U.S. Census Bureau's 2023 American Community Survey 5-Year Estimates, Detailed Tables, at the block group level (ACS 2023, U.S. Census Bureau. American Community Survey 5-Year Estimates, Detailed Tables. U.S. Department of Commerce. Data retrieved using the Census API for Shelby County, Tennessee block groups [71–73]). The ACS sources used for the CDI calculation are listed below:

1. Poverty Rate: Percent of individuals living below the federal poverty line.
ACS Table C17002: Ratio of Income to Poverty Level in the Past 12 Months
Variables used: C17002_001E, C17002_002E, C17002_003E
2. Public Assistance/SNAP Rate: Percent of households receiving public assistance or welfare income
ACS Table B19058: Public Assistance Income or Food Stamps/SNAP in the Past 12 Months for Households
Variables used: B19058_001E, B19058_002E
3. Female-Headed Household Rate: Percent of female-headed families with no spouse present.
ACS Table B11001: Household Type
Variables used: B11001_001E, B11001_006E
4. Unemployment Rate: Percent of individuals aged 16 and older in the civilian labor force who are unemployed
ACS Table B23025: Employment Status for the Population 16 Years and Over
Variables used: B23025_003E, B23025_005E
5. Youth Population Rate: Percent of the population younger than age 18.
ACS Table B01001: Sex by Age
Variables used: B01001_001E, B01001_003E, B01001_004E, B01001_005E, B01001_006E, B01001_027E, B01001_028E, B01001_029E, B01001_030E
6. Percent Black/African American: Percent of the population that is Black/African American
ACS Table B02001: Race
Variables used: B02001_001E, B02001_003E

The CDI used in thematic mapping included percent Black/African American.

Each indicator is converted to a percentage, standardized using z-scores, and combined into a composite CDI score using the mean z-score approach. We joined ACS variables to the Memphis block group dataset using GEOID identifiers [71]. The GEOID was used as the geographic identifier to join the ACS block group data with the Memphis block group shapefile and attribute table.

The resulting dataset included 546 City of Memphis block groups, of which 448 observations contained complete information for all variables including CDI used in the path analysis and thematic mapping with blight, litter, and crime.

Walkability Index. The City of Memphis dataset was synthesized based on the project aim, <https://data.memphistn.gov/datasets/MEMEGIS::shelby-county-walkability-index-1/about>, accessed on 27 February 2026.

Racial Composition. The U.S. Census Bureau's American Community (ACS), 2024: ACS 5-Year Estimates Detailed Tables, table B02001, [https://data.census.gov/tables/ACSDT5Y2024.B02001?t=Race+and+Ethnicity&g=050XX00US47157\\$1500000&y=2024&d=ACS+5-Year+Estimates+Detailed+Tables](https://data.census.gov/tables/ACSDT5Y2024.B02001?t=Race+and+Ethnicity&g=050XX00US47157$1500000&y=2024&d=ACS+5-Year+Estimates+Detailed+Tables) (accessed on 18 November 2024).

Census Block-Group. EPSG. NAD 1983 StatePlane Tennessee FIPS 4100 (US Feet) (EPSG:2274). EPSG.io. <https://epsg.io/2274> (accessed on 6 March 2025).

The path analysis model was estimated by Maximum Likelihood (ML) in R. Goodness of fit is stated with various indicators in ML (see Shi et al. [81]). The model produced the following fit statistics:

Chi-Square Test ($\chi^2 = 20.422$, d.f. = 6, $p = 0.002$). The p -value is less than 0.05, which indicates statistical significance. Comparative Fit Index (CFI = 0.985) indicates excellent fit.

Tucker–Lewis Index (TLI = 0.931) indicates acceptable fit. Root Mean Square Error of Approximation (RMSEA = 0.066) indicates good or acceptable fit. Standardized Root Mean Square Residual (SRMR = 0.022) indicates excellent fit. Overall, the model fits the data well.

We also developed a second path analysis model, in which the concentrated disadvantage index (CDI) replaces Black/African American population proportion while maintaining the same model structure (see Section 3.1 above). This index captures the vulnerable urban population’s socio-economic characteristics used in crime and public health studies [75,80]. Although the path model with CDI included demonstrates acceptable fit and statistically significant pathways, its overall explanatory performance is slightly weaker than the previously estimated model using Black population proportion. However, both specifications provide useful insights and comparable statistics. Combining the two path models with the inclusion of CDI and racial composition remains a plausible direction for future investigation. Table 1 summarizes the direct, indirect, and total effects of CDI among other variables on crime.

Table 1. Direct, indirect, and total effects of concentrated disadvantage index (CDI) and other variables on crime.

Variable	Direct Effect on Crime β (p -value)	Indirect Effect on Crime β (p -value)	Total Effect on Crime β (p -value)
CDI	--	0.073 (<0.001)	0.073 (<0.001)
Ln Income	--	−0.043 (0.003)	−0.043 (0.003)
Ln Population Density	−0.204 (<0.001)	−0.077 (<0.001)	−0.281 (<0.001)
Walkability	0.292 (<0.001)	0.041 (<0.001)	0.333 (<0.001)
Ln Simpson Diversity	--	−0.054 (0.013)	−0.054 (0.013)
Ln Blight	0.254 (<0.001)	−0.057 (0.071)	0.196 (<0.001)
Ln Litter	−0.092 (0.069)	--	−0.092 (0.069)

Note. Standardized coefficients (β) are shown with p -values in parentheses. The path analysis model includes log-transformed and standardized variables. A double dash (--) indicates no direct or indirect variable effect in the path model. Fit Statistics: $\chi^2 = 27.553$; d.f. = 6; p -value < 0.001; CFI = 0.978; TLI = 0.898; RMSEA = 0.090; SRMR = 0.024. Explained variance: R -squared values: 0.357 for Ln Blight, 0.410 for Ln Litter, and 0.220 for Ln Crime. The model was estimated with 448 complete observations (block groups).

3.3. Path Model Results

All variables included in the path model(a) are statistically discernable at the 0.05 percent level or higher. Land use diversity is a durable principle of sustainable urbanism, advocated from The Death and Life of Great American Cities [30] to New Urbanism [36,41,60,82]. Measured via the Simpson diversity index, land use mix turns out to be the strongest predictor of blight with a standardized coefficient value of $\beta = -0.369$ and highly statistically significant (p -value < 0.001). Blight decreases with increasing land use diversity. Also increasingly highlighted in discussions of urban sustainability is the relative importance of walkability. Walkability is a direct predictor of blight ($\beta = 0.247$) and is statistically significant (p -value < 0.005). Income has an inverse relationship with blight, as expected. Blight decreases with increasing income ($\beta = -0.307$). Density is the second strongest predictor of blight ($\beta = -0.325$) and is highly significant. Density’s direct effect on crime ($\beta = -0.085$) is significant (p -value < 0.05). Aligned with observations of “eyes on the street,” population density is inversely related to crime. Noteworthy, are the

mediating effects of blight and litter on crime. Blight and litter explain 36.3 percent and 40.3 percent of the variation in crime, respectively. Blight is a stronger predictor of crime compared to litter ($\beta = 0.568$ and $\beta = 0.244$, respectively), and both are highly statistically significant (p -values < 0.001). Thereby, the broken windows theory of crime is revisited.

Our second path analysis model indicates that concentrated disadvantage (CDI) has an indirect effect on crime (Table 1). Stated differently, crime increases with increasing values of CDI ($\beta = 0.073$) and is highly statistically discernable (p -value ≤ 0.001). The effects of the other variables are similar to those in the first path analysis model. Population density has a negative total effect on crime, while walkability has a positive total effect. Blight has a positive direct effect on crime and remains influential after accounting for its indirect pathway through litter. Litter has a negative direct effect on crime in this model (p -value = 0.07). All other coefficients are statistically discernible. However, compared to the first path model that explained 26.2% of the variance in crime, the second model explained 22%. The R -squared results for blight and litter are nearly identical.

3.4. Thematic Mapping of CDI and BLC–CDI Presence

Two thematic maps complement the path analysis with the geography of concentrated disadvantage (CDI) and blight, litter, crime (BLC) hotspots. Concentrated disadvantage index values are classified using graduated quantile classes. The BLC–CDI Presence represents the number of elevated factors present in each block group. Elevated values are defined as values at or above the 75th percentile for blight proportion, litter proportion, crime per 1000 residents, and CDI. The copresence map shows the number of elevated factors present, not the specific combination of factors in each block group.

Figure 2 shows the spatial distribution of the concentrated disadvantage index (CDI), while Figure 3 shows the presence of blight, litter, crime (BLC) and CDI in block groups.

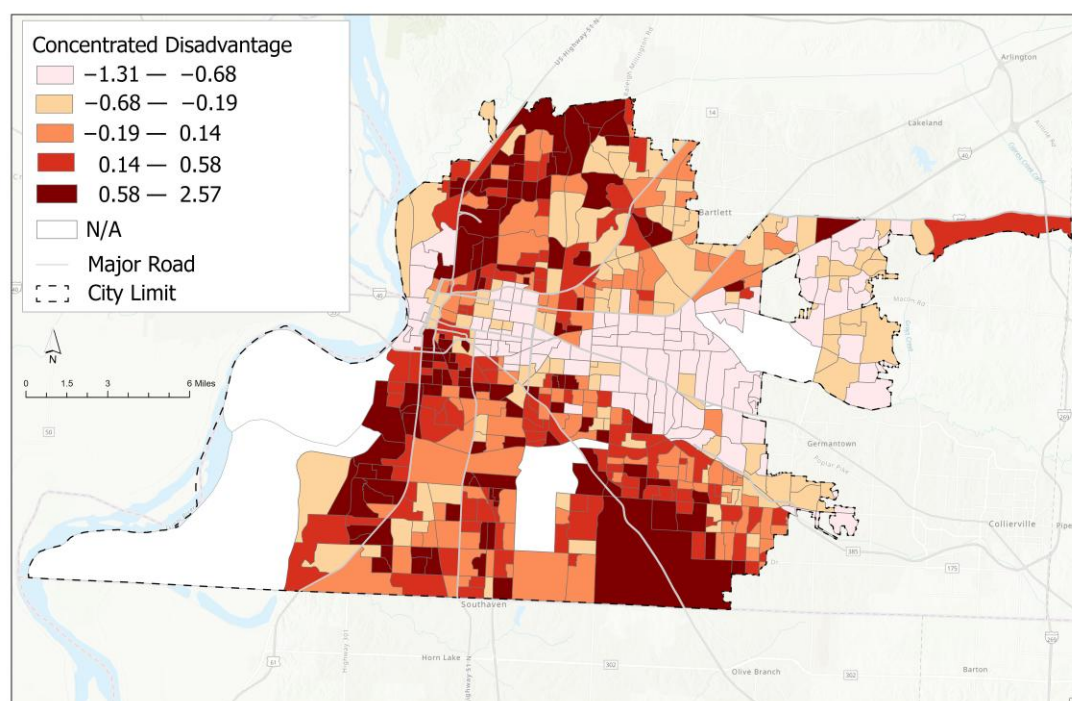


Figure 2. Spatial distribution of concentrated disadvantage index (CDI) across Memphis block groups. Sources: U.S. Census Bureau ACS 2023 5-Year Estimates, Detailed Tables; U.S. Census Bureau TIGER/Line block group boundaries; City of Memphis data; Esri basemap.

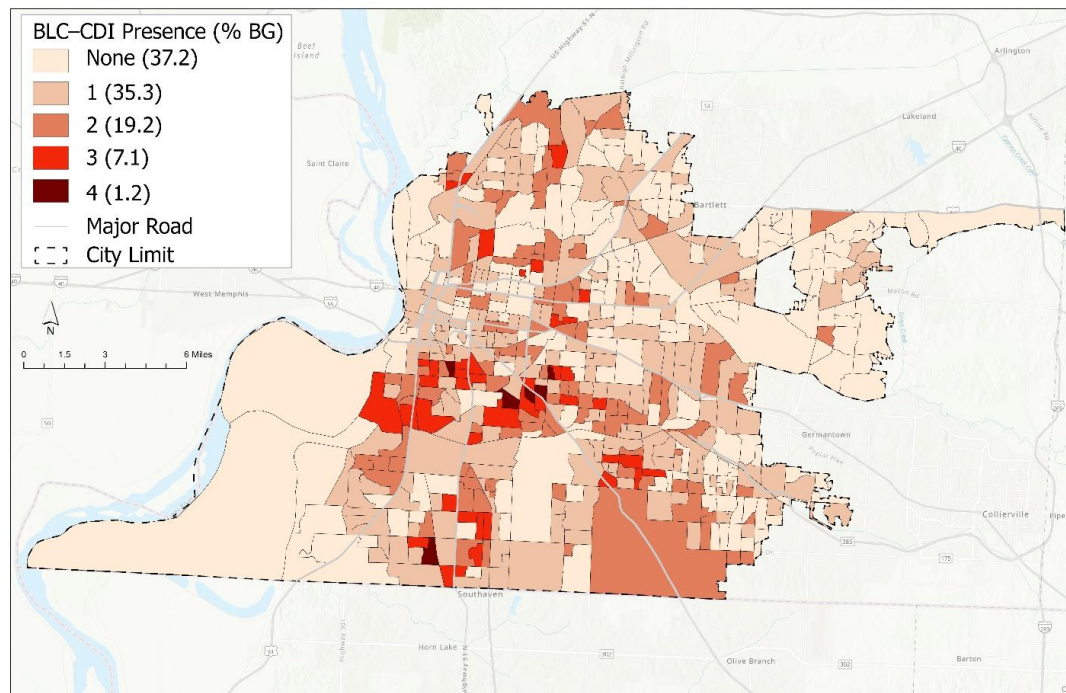


Figure 3. Blight, litter, crime (BLC) and concentrated disadvantage index (CID) as percent of block groups (BGs). Sources: U.S. Census Bureau ACS 2023 5-Year Estimates, Detailed Tables; U.S. Census Bureau TIGER/Line block group boundaries; City of Memphis data; Esri basemap.

This CDI includes percent Black/African American residents combined with poverty rate, public assistance/SNAP rate, female-headed household rate, unemployment rate, and youth population rate (see definition in Section 3.2). CDI values were classified into five graduated categories: from low to high. Because CDI was constructed using standardized values, the index includes both negative and positive values. Negative values indicate lower levels of concentrated disadvantage relative to the citywide distribution, while positive values indicate higher levels of concentrated disadvantage.

Of the 546 Memphis block groups, 541 had valid CDI values, and 5 block groups, or 0.92%, had missing CDI values. The CDI class distribution was as follows: 109 block groups, or 19.96%, were classified as Very Low; 108 block groups, or 19.78%, as Low; 108 block groups, or 19.78%, as Moderate; 107 block groups, or 19.60%, as High; and 109 block groups, or 19.96%, as Very High. Overall, 216 block groups, or 39.56%, of all Memphis block groups were classified as High or Very High CDI.

The BLC–CDI Presence indicates how many of the four path analysis factors—blight, litter, crime, and CDI—are elevated within each block group. Elevated values were defined as values at or above the 75th percentile for each factor. The 75th percentile thresholds were 23.80 for blight proportion, 7.37 for litter proportion, 15.46 for crime per 1000 residents, and 0.45 for CDI.

Each block group factor is a binary. A value of 1 indicates the factor is elevated, which is otherwise given a value of zero. The four binary indicators are summed to create a presence score ranging from 0 to 4. A score of 0 indicates that none of the four factors are elevated, while a score of 4 indicates that all four factors are elevated in the same block group.

The distribution of the presence score shows that most Memphis block groups do not contain multiple elevated conditions simultaneously. Of 546 block groups, 203 block groups, or 37.2%, had no elevated factors. Another 193 block groups, or 35.3%, had one elevated factor. Together, these two categories account for 396 block groups, or 72.5%, of all Memphis block groups.

Higher levels of copresence were found in a smaller number of block groups. A total of 105 block groups, or 19.2%, had two elevated factors; 39 block groups, or 7.1%, had three elevated factors; and only 6 block groups, or 1.1%, had all four factors elevated. These six block groups represent the highest level of BLC–CDI Presence, where blight, litter, crime, and concentrated disadvantage are all elevated in the same locations.

Comparing the CDI map with the BLC–CDI Presence map shows that areas with higher copresence are strongly associated with higher CDI categories. Among the 45 block groups with high or full copresence scores, meaning scores of 3 or 4, 39 block groups, or 86.67%, were also classified as High or Very High CDI. This suggests that the highest levels of combined blight, litter, crime, and concentrated disadvantage are largely concentrated in block groups with elevated CDI values.

Overall, the maps show that concentrated disadvantage and the combined presence of blight, litter, and crime are spatially uneven across Memphis. The CDI map provides the background geography of neighborhood disadvantage, while the BLC–CDI Presence map identifies the subset of block groups where multiple elevated neighborhood conditions occur simultaneously. This combined mapping approach helps distinguish areas with High CDI alone from areas where CDI coincides with elevated blight, litter, and crime. Accordingly, targeted planning priorities and policy strategies for neighborhoods that block groups represent toward urban revitalization are suggested (see also Discussion, Section 4).

4. Discussion

By invoking land use and the city block, and, increasingly, GIS-aided spatial analysis of crime patterns, recent criminological studies resemble the Chicago School of urban sociology that pioneered, in the first decades of the twentieth-century, mapping the morphology of city growth and decay, albeit combined with ethnography [42–44]. Recently, the urban studies literature has commonly labeled this approach as a “mixed method”. It turns out that the Chicago School’s socio-spatial mapping predates the popularity of mixed methods in urban studies. The mapping carved out the city by a set of concentric zones, from the city center outward to the “commuters’ zone”. The “transition zone” near the factory and downtown revealed the location of dilapidated housing and shops, homelessness, and crime. The zones characterize the city residents’ neighborhoods, differentiated by income and social grouping and household mobility.

Recent studies also used the city block and differentiated land use (residential, commercial, industrial, park and open space) as well as the mix and density of land use in observations of crime and litter [31,35,46]. Empirical studies of crime increasingly align with urban morphology by drawing on physical form, albeit, like the Chicago School, descriptively rather than prescriptively (or normatively), akin to New Urbanism or sustainable urbanism [18,44,83]. The physical formal qualities that New Urbanism and sustainable urbanism prescribe include walkability, multimodal access including public transit, proximity achieved with land use mix, the variety of housing types that increase affordability, jobs/housing/services balanced with regional mobility and accessibility [36,41,53,67,83].

The New Urbanism morphology includes density, land use mix, and walkability. They function synergistically, rather than singularly. Density ensures compact urban form, though, without land use mix, propagates car dependency instead of walkability. Density itself is deconstructed by interrelated, constituting components—density, diversity, design, destination [39,84,85] (for a discussion of density, see also Banai [86]). We set out to determine the impact of such a morphology on the incidence of blight, crime, and litter. However, unlike studies in which blight, crime, and litter are commonly measured as if unrelated, we determine their relationship explicitly. The interrelationships are determined by a set of direct and indirect factors in a path analytic model informed by urban

morphology calibrated statistically in R [87,88]. The explanatory (exogenous) variables combine urban form with socio-economic factors, and the spatial unit of analysis is the block group that approximates neighborhoods. Thereby, the path model effectively adds luster to the weights of the determinants of the urban spatial structure that are heretofore eclipsed in urban morphology as well as urban criminology, informed by New Urbanism.

With a finer spatial unit than the census tract, the block group geography enables readily available socio-economic census data. We used block group population density, median income, race, and concentrated disadvantage in our path models. We determined land use mix with the Simpson diversity index, and we retrieved a walkability score, available in the public domain. Furthermore, we calculated the concentrated disadvantage index (CDI), which is a metric that reflects the clustering of socio-economic indicators for the disadvantaged population group with census data and included exogenously in a path analysis.

Future research plausibly beneficially investigates the correlations of blight, crime, and litter at an even higher resolution, parcel level within neighborhoods, intensive data collection requirements notwithstanding. Our path analytic models with block groups that approximate the neighborhood are a venue toward that higher-resolution investigation of the correlations of blight, crime, and litter. Further research plausibly refines the path model with additional factors also included in discussions of urban morphology. Parks and open spaces at various scales from small “pocket park” comparable in size to a single-family lot to the neighborhood and regional scale are among the factors plausibly considered in the relationships of blight, litter, and crime. Alternative indicators of density other than population include dwelling unit per unit of area, public transit availability, and regional mobility with access to jobs and services also commonly discussed in urban morphology and sustainable urbanism [67,83–85].

Our path analytic models specified the structure and determined the degree and significance of the direct and indirect relationship between blight, crime, and litter endogenously with socio-economic-spatial indicators at the block group level exogenously, including land use (mix), density, walkability, income and race. We augmented block group-level census economic and demographic data with local government land use and institutional documentation of the neighborhood condition, public safety, and 311 calls: incidents of blight, crime, and litter, respectively, for a case study of Memphis, Tennessee. However, our path analytic models accounted for 35.7%, 41%, and 22–26.2% of the variations in blight, litter, and crime, respectively. Our urban morphology-informed path analysis models resulted in highly statistically discernable coefficients (with the exception of walkability that exceeded the 0.05 threshold) of the urban form combined with socio-economic factors in a structural relationship to blight, litter, and crime, despite the low coefficient of determination (indicated by R-squared values). However, we emphasize that while our path analysis is further refined by the inclusion of the unobserved urban form and socio-economic variables (i.e., the residual term e in regression), we focused on urban morphology rather than urban criminology. Urban morphology is eclipsed in recent studies of blight, litter, and crime relationships despite the insertion of space in urban criminology.

What socio-economic and physical form variables at an even finer resolution than the block group increase the predictive power of the path models, and thereby effectively inform and fine-tune planning and public policy targeted to the alleviation of neighborhood blight, litter, and crime, suggests a plausible area of further investigation.

5. Urban Revitalization Implications

Our path analysis results of blight–litter–crime connections directly and indirectly linked to urban form and socio-economic factors have implications for neighborhood revitalization and strategic intervention.

The positive total effect of concentrated disadvantage on crime (CDI in second path model, Table 1) is through direct rather than indirect pathways. Concentrated disadvantage with manifest persistent hotspots is a challenge in urban policy that aims to de-concentrate poverty, particularly in the inner city [36,54,55,75] (see also Figure 2). Addressing concentrated disadvantage is, thus, plausibly regarded as an additional strategic intervention to reduce crime in cities, among others. Population density's negative total effect on crime lends further support to planning initiatives that stabilize or reverse the declining neighborhood residential population with infusions of locally oriented services, particularly in "food deserts". However, walkability's positive total effect on crime is counter to expectations, which merits further investigation of the site-specific conditions in neighborhoods that are walkable but still experience crime.

Blight's positive direct effect on crime remains influential after accounting for its indirect pathway through litter. This finding is in lockstep with urban planning priorities that target blight and litter [35]. However, the negative impact of litter on crime is not statistically discernable at the 0.05 or higher level, as is the rest of our results.

Urban renewal discussions commonly reference redlining, segregation, and environmental pollution (injustice) maps that depict the disproportionate burden on the affected population in poverty. It turns out that our mapping of the concentrated disadvantage index (CDI) across Memphis block groups is even more widespread, not just limited to the blocks inside the beltway (Figure 2). This suggests revitalization initiatives to target neighborhoods comprehensively responsive to the segmented populations that constitute the concentrated disadvantage index holistically—the poor, on public assistance, female-headed households, and youth. The comprehensive plan is a perfect tool to address housing, daycare, transportation infrastructure, and access to jobs and services locally and regionally in neighborhoods with concentrated disadvantage [54,55,67]. The combination of blight, litter, crime, and CDI adds to the urban revitalization challenges (Figure 3). This pattern suggests that the highest spatial concentration of disadvantage (CDI), blight, litter, and crime (BLC) is limited to a small set of block groups and not broadly distributed across the city. The block groups with three- to four-factor co-presence, locations where multiple neighborhood challenges occur simultaneously, suggest priority areas for further investigation and targeted intervention.

6. Conclusions

We determined the relationship between blight, crime, and litter using a path analytic model with (exogenous) variables that are informed by physical formal qualities prescribed by normative theories of urban form. The elements of physical form, from parcel and the street to the city block, appear piecemeal in the literature when used to investigate blight, crime, and litter in cities. Normative theories of urban form include New Urbanism, which states a set of desirable qualities that contrast urban sustainability with sprawl, which we posited concomitantly with "disorder", both physical and social. It turns out that discussions of disorder link behavior to the environment, descriptively and prescriptively, from the nineteenth-century Garden City to the Chicago School of urban sociology to New Urbanism.

In contrast with existing studies, our path analytic models measure blight, litter, and crime in relation to the interrelated urban form elements holistically rather than in isolation [6,9,45,48]. Specifically, blight and litter have a mediating effect on crime. The observations of the effects of the exogenous variables—density, land use diversity, walkability, income, and race—on blight, litter, and crime are generally in alignment with expectations. Geographically weighted, population density is positively related to crime, interpreted by denser neighborhood vulnerability to criminal activity [27]. However, mediated by blight

and litter in our path model, density is negatively related to crime. Thus, we find less crime in denser neighborhoods, with more eyes on the street.

Finally, our path analytic models of blight, litter, and crime with direct and indirect relationships to the socio-spatial elements of urban form—density, land use diversity, walkability, block group median income, racial composition, and concentrated disadvantage—have strategic implications for urban revitalization [65] (p. 309). See also [67], which identified an urban revitalization typology for the U.S. This typology is characterized by catalytic, downtown, neighborhood, and project-focused revitalization. The path analytic, urban form elements in direct and indirect relationships to blight with relative importance suggest strategic priorities for revitalization. For example, projects that are considered as catalytic or anchor are specifically assessed with respect to increased density, land use diversity, and walkability, reflecting relative importance in context. Other types of urban revitalization are assessed in a similar vein toward a desirable outcome.

Author Contributions: Conceptualization, R.B.; methodology, R.B.; software, R.B. and N.E.S.; validation, R.B. and N.E.S.; formal analysis, R.B.; investigation, R.B. and N.E.S.; resources, R.B. and N.E.S.; data curation, R.B. and N.E.S.; writing—original draft preparation, R.B.; writing—review and editing, R.B.; visualization, R.B. and N.E.S.; supervision, R.B.; project administration, R.B. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: Data supporting the reported results, including links to publicly archived datasets, are listed in Section 3.2.

Conflicts of Interest: The authors declare no conflicts of interest.

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